

$$L = W = 2$$

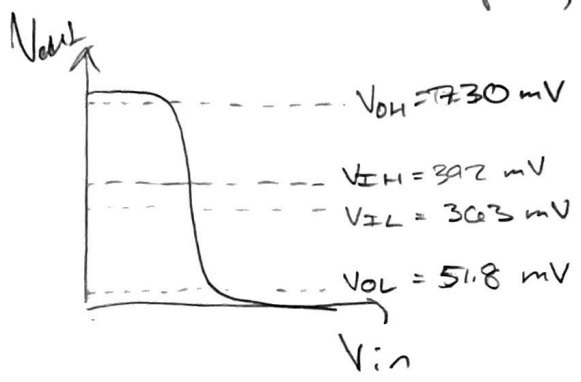
1. * attached



eyeballing: slope of -1 (on spice plot)

$$V_{IL} = 356 \text{ mV} \quad 363 \text{ mV} \rightarrow V_{OH} = 0.73 \text{ V}$$

$$V_{IH} = 400 \text{ mV} \quad 392 \text{ mV} \rightarrow V_{OL} = 0.052 \text{ V}$$



$$5. \quad NM_H = 730 \text{ mV} - 392 \text{ mV} = 338 \text{ mV}$$

$$NM_L = 363 \text{ mV} - 51.8 \text{ mV} = 311.2 \text{ mV}$$

3. * attached

4. propagation delay: input 50% \rightarrow output 50%
400mV \rightarrow 400mV

$$3.57 \cdot 10^{-10} \text{ s} \rightarrow 4.207 \cdot 10^{-10} \text{ s}$$

propagation delay: 63.7 ps

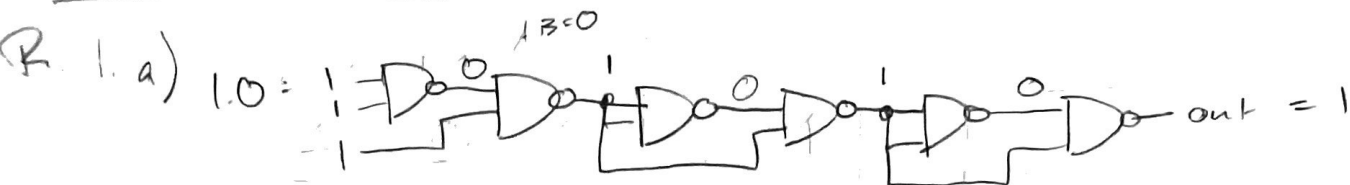
rise time: 10% \rightarrow 90%
80mV \rightarrow 720mV
 $3.297 \cdot 10^{-10} \text{ s} \rightarrow 4.19 \cdot 10^{-10}$

rise time: 89.3 ps

Ce. $\tau = \frac{\text{rise time}}{2.2} = \frac{89.3}{2.2} \text{ ps} = 40.59 \text{ ps}$

$$\tau = RC = 40.59 \text{ ps} \rightarrow R_{in} = \frac{40.59 \text{ ps}}{C} = \frac{40.59 \cdot 10^{-12} \text{ s}}{0.05 \cdot 10^{-15} \text{ F}}$$

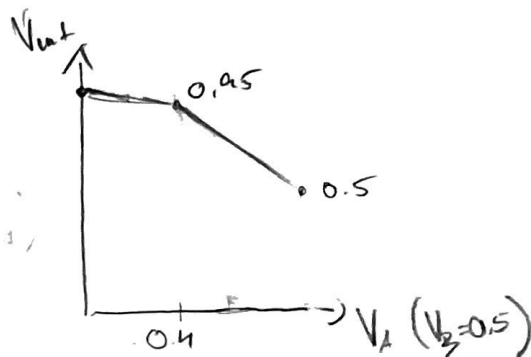
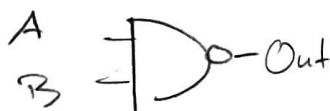
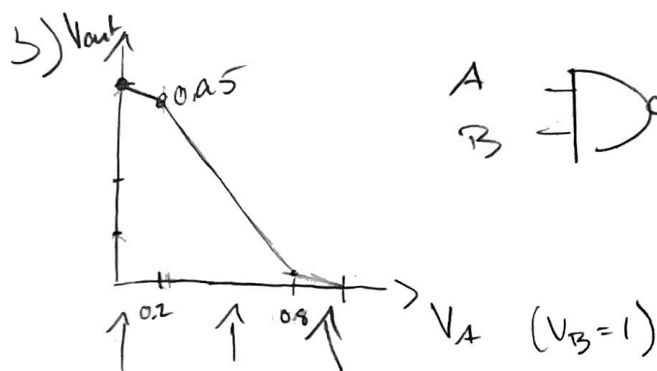
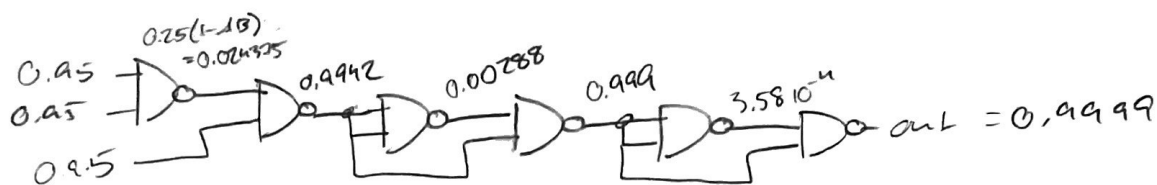
$$= 812 \text{ k}\Omega$$



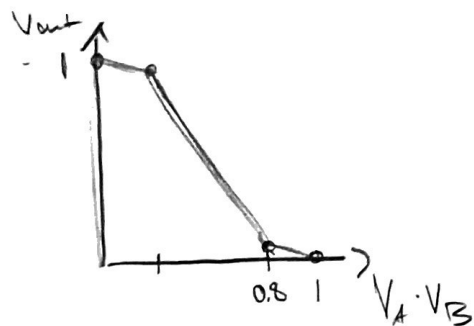
$$A \cdot B > 0.8 : Out = 0.25 - 0.25(A \cdot B) = 0.25(1 - AB)$$

$$0.8 > A \cdot B > 0.2 : Out = 1.25 - 1.5(A \cdot B)$$

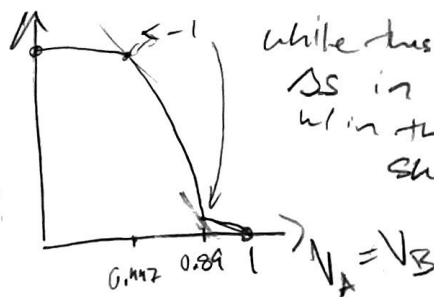
$$A \cdot B < 0.2 : Out = 1 - 0.25(A \cdot B)$$



$$\frac{\partial V_{out}}{\partial V_A} = -0.25$$



Lets consider $V_A = V_B$ as the input to channel 2.



While these are instantaneous SS in slope, (-1) lies within the range that they ship

$V_{TL} = 0.447V$ ← the max "low" voltage $V_A \neq V_B$ can both be before distortion

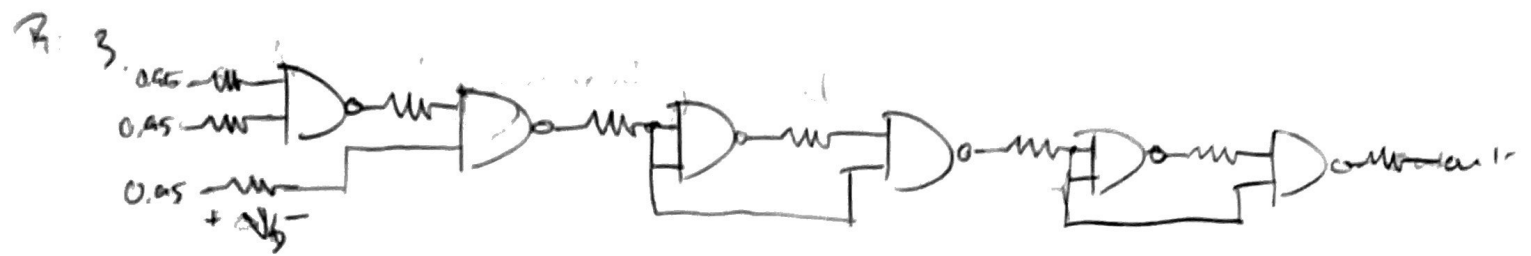
$V_{TH} = 0.89V$ ← the min "high" voltage $V_A \neq V_B$ can both be

$$V_{OH} = 0.95V$$

$$V_{OL} = 0.05V$$

$$NM_H = 0.95V - 0.89V = 0.06V$$

$$NM_L = 0.447V - 0.05V = 0.397V$$



Since V_D is no input to any node is between V_{IL} & V_{IH}

~~$V_D < NM_H$~~

$V_D < NM_H$
 $V_D < NM_L$

$V_D = \min(NM_H, NM_L)$
 $= NM_H = 0.050V$

↑ voltage drop

4. a) * attached

b) $V_{IL} = 1.06V$

$V_{OH} = 3.7V$

$V_{IH} = 1.84V$

$V_{OL} = 0.25V$

$NM_H = V_{OH} - V_{IH} = 1.86V$

$NM_L = V_{IL} - V_{OL} = 1.35V$